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May 1980

# Agricultural Research

# The Role of Research and Extension in USDA Energy Programs*

by Jim Williams
Deputy Secretary of Agriculture*

At USDA, much of the research and extension efforts in our energy programs are directed toward increasing the availability of woody and agricultural biomass materials. These materials are used not only to produce alcohol fuels, but also for direct combustion and other forms of energy. Our alcohol fuels program is an important component of the total biomass and synthetic fuels production effort of the Department.

The President's gasohol program has established a goal of 500 million gallons of alcohol fuel capacity in place by 1981. About 80 million gallons of annual on-line capacity currently exists; 420 million gallons of additional capacity is necessary to reach this goal. This dramatic increase in ethanol production for gasohol for passenger and commercial vehicles and as direct fuel in farm power equipment will not be easy to achieve.

USDA has developed a six-point alcohol fuels effort to assist in meeting this goal. These include:

- financial assistance for commercial-scale plants
- financial assistance for small and community-scale plants
- management of domestic commodity and other farm programs to include alcohol production
- research and development
- technical assistance for small-scale producers
- increased export sales of alcohol byproducts.

**Research and Development**

Much of the research on biomass and alcohol fuels will be conducted through SEA energy research centers located in Peoria, Illinois and Tifton, Georgia, and at the Forest Service (FS) Products Laboratory in Madison, Wisconsin.

At Peoria, SEA researchers are screening thousands of crops for starch and sugar content, examining other biomass materials to be utilized in large-scale conversion into alcohol fuels and evaluation of large-scale conversion processes.

At Tifton, they are evaluating the production, harvesting, and conversion of wood and crop biomass to alcohol and other energy forms, and using small-scale biomass energy systems on the farm. At the Madison laboratory, researchers are examining conversion technologies for using wood as a source of energy and petrochemical substitutes.

The research efforts within USDA relating to alcohol fuels production include development and selection of higher production feedstocks; more efficient conversion of these feedstocks into fuel alcohol; development of technology to allow the economic use of new feedstocks; and an assessment of the impact of the alcohol fuels program on agriculture, forestry, and rural areas of the United States.

Another important SEA and FS research area is the screening of large numbers of plants which show promise for total biomass production, high yields of hydrocarbons, and the development of substitutes for petroleum products. Research efforts also include enhancing biomass plant production through selective genetics and plant breeding.

The cultural and management practices associated with maximizing total production per unit area of sugar and cellulosic biomass materials are being evaluated at the Peoria Agricultural Energy Research Center. Initial emphasis will be on crops such as sweet sorghum and sweet stalk corn. These will be evaluated in greenhouse and field-plot tests to determine appropriate management practices necessary to produce maximum yields with differences in climate, soil, water, fertilizer, and other management practices.

Research is also underway at Peoria with cooperating land-grant institutions under grants from the 1977 Food and Agriculture Act to enhance the fermentation and chemical conversion process. This involves selection and evaluation of microorganisms for the ability to produce alcohol at a higher concentration, greater rate, or to function under a variety of fermentation conditions and substrate types and concentrations.

**Technology Transfer**

One way to rapidly expand alcohol fuels production from biomass is through adoption of an active technical assistance program. SEA-Extension, the Cooperative Extension Service (CES), and the FS state and private forestry component are shifting their resources to place greater emphasis on energy-related programs.

Some additional funding to expand programs has come as pass-through funds from the Department of Energy (DOE) with CES in some states receiving funding from state energy offices. Seven of the ten pilot DOE Energy Extension Service programs have been operated in cooperation with CES. In many states, CES has submitted proposals to conduct the Energy Extension Service program as it expands nationwide.

The Cooperative Extension Service is stressing information transfer on alternative forms of renewable energy sources for use on farms and in rural communities. The production and use of alcohol fuels are receiving particular emphasis because of the potential to supply motor fuel needs from local feedstocks and the creation of extra markets for agricultural products.

CES provides information to their county offices on the alcohol fuels program as rapidly as technical information and loan assistance information becomes available. Farmers and small businesses in rural communities are extremely interested in examining the issues and opportunities in producing alcohol. Initial feedback from a number of states indicates that interest is more on community-based plants, rather than on individual farms, because of the advantages of maintaining quality, safety control, and fewer storage problems.

USDA agencies, including SEA, have also developed specialized training and educational materials, including publications and films, to help extension specialists and county agents assist operators of small-scale facilities in the production of alcohol.

* Excerpts from a statement by Jim Williams, Deputy Secretary of Agriculture, before the Senate Committee on Agriculture, March 1980.

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Photo p. 13 courtesy
Grant Heilman.

Cover: These tiny (8-mm broad) *Cyathus stercoreus*—commonly called "bird's nest fungus" or "fairy goblets"—grow on cattle dung and help convert plant stems, stalks, and straw into alcohol fuel. The only species of *Cyathus* to grow naturally on manure, they are being studied at the SEA Northern Agricultural Energy Center in Peoria, Ill. Story begins on page 8 (0180X057-3).

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# Future Power for America — New Agricultural Energy Centers

By 1990—ten years from now—farmers and ranchers should be able to create as much energy as they use to produce our harvests of food and fiber. Beyond 1990, they should be producing enough farm-generated energy to power other parts of the American economy, too.

That's the goal set for scientists and extension officials selected to work in two new agricultural energy centers being established by SEA.

The centers, located in Tifton, Ga., and Peoria, Ill., will conduct and coordinate programs that take different approaches to the common goal.

At Tifton, the programs will seek new and improved methods to generate energy on the farm and better ways for farmers and ranchers to put that energy to work.

The programs at the Peoria center will concentrate on converting farm or forest-produced "biomass" into fuel alcohol or petrochemical substitutes.

SEA is supporting research at the Tifton energy center for the first three quarters of 1980 with $1.6 million, plus $200,000 to be allotted for extension activities. The Peoria energy center will receive $2 million, which includes $100,000 for extension work. An additional $2.4 million will be awarded for special extramural projects on agricultural energy. Final approval for both centers was given in December 1979.

Above: In this Tifton, Georgia, study, solar energy is used to increase plant growth. Water—heated by solar collectors—is pumped into storage tanks inside an adjacent greenhouse. Technician Donald Tyson and researcher James Butler (background) inspect water-tight seals on the collectors (0380X281-8).

Right: Solar-heated water is stored in concrete block tanks that are waterproofed and insulated. Plants demonstrate increased growth when placed directly over the storage tanks (one insulation panel has been removed for photo). Butler and Tyson discuss the root system of a growth-enhanced plant (0380X282-14A).

**Tifton Programs**

Regional solar energy research and development centers, along with model farms and demonstration projects, are specifically called for in the Food and Agriculture Act of 1977. The Act defines solar energy as energy derived from all forms of renewable sources including direct solar heat, wind, and biomass.

Groups of researchers at the Tifton center will work on these aspects of solar energy: direct solar energy use, ways to produce and harvest biomass, and ways to convert biomass into useful energy.

The Tifton center will coordinate additional research programs at Ames, Iowa; Bushland, Tex.; and Columbia, Mo. At Ames, scientists will concentrate on using wind energy for heating and environmental control for both humans and farm animals. At Bushland, wind energy research will be designed to find more efficient ways to irrigate farm crops.

At Columbia, work will continue on making swine production more energy self-sufficient by using swine waste to generate methane gas.

At the center site in Tifton, engineers and technicians in one research group will develop both equipment and methods to harvest, store, and process biomass on the farm. The sources of the biomass could include farm crops, trees, aquatic plants, crop residues, prunings, unmarketable crops, and animal wastes, as well as new crops specifically produced for biomass.

A second Tifton research group will seek ways to unlock the energy in biomass by using it to generate methane gas, turning it into alcohol, converting it chemically with heat, or simply by burning it. The researchers will work on methods of using biomass energy in conventional devices such as crop dryers, motorized farm equipment, and with minimum change, equipment for farm and home environmental control. Researchers will also investigate potential uses for leftover residues from biomass after the energy is released.

A solar applications research group will seek new methods and equipment to collect, store, and use solar heat for crop drying, refrigeration, water heating, and environmental control in animal and human shelters. This group will also develop computer programs on alternative energy forms for agricultural production.

**Peoria Programs**

The 1977 Food and Agriculture Act also authorized research on the production of alcohols and industrial hydrocarbons from farm and forestry products and residues. This will be the major subject of studies and extension activities at the Peoria agricultural energy center and in programs at other locations that are coordinated by the Peoria center.

Scientists involved in the Peoria-based research effort will investigate: converting biomass materials into fuel alcohols; and producing and harvesting biomass. About half of the research work will be on basic fermentation and chemical conversion of plant-based biomass.

Until new "energy crops" are discovered, developed, and grown specifically for an "energy harvest," ordinary grains, starchy roots, and sugar crops must be used as biomass "feedstocks."

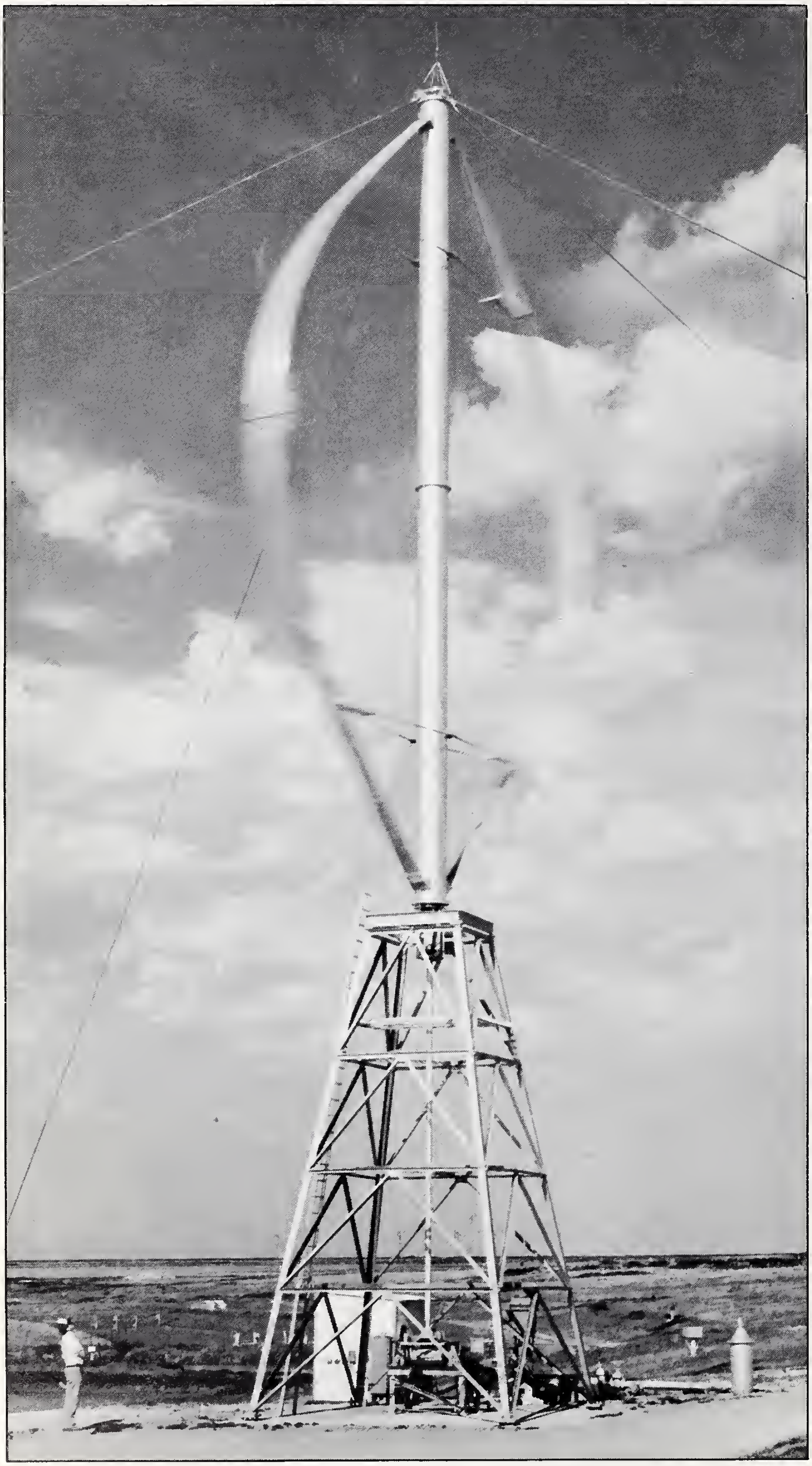
Investigations at the center are being made on the use of new microorganisms to convert starch and cellulose of feedstock plants into sugars suitable for fermentation into alcohol.

Another major aspect of the center's energy conversion work will be developing economic ways to chemically recover hydrocarbons from biomass. Researchers will attempt to chemically or physically modify hydrocarbons and other plant constituents into petrochemical replacements.

After the biomass has been used to make alcohol or methane, researchers will study the best ways to produce protein-concentrate food or feed products from the residue. This byproduct development activity is considered to be an important part of the Peoria center's processing study.

Top: Butler and technician Jehu Walker (background) adjust an experimental solar-powered still used to produce alcohol fuel. Prior research suggests that 500 to 700 gallons of alcohol can be distilled from just one acre of sweet sorghum—one of the most promising of several fermentation materials being evaluated (0380X283-3A).

Above: "Animal wastes can have a dual energy use," suggests Butler. He extracts methane from manure for use as fuel. The remaining material, having lost none of its plant nutrients, is used as fertilizer (0380X280-5).



Other Peoria investigations will include ways to use low-proof alcohol as fuel and the use of stabilizing agents for low-proof alcohol-gasoline and alcohol-diesel blends.

To provide biomass sources, there will be a screening and selection program at Peoria to find plants with the most potential to produce energy or petrochemical substitutes. A part of this work will be a study of basic plant structure, including the bonding characteristics of lignin and cellulose. (An example of this research is

Above: Wind-powered generators for rural homes are being studied by SEA engineers at Ames, Iowa. This horizontal-axis downwind turbine, outside a home in Bloomfield, Iowa, can produce 15 kW in a 26-mph wind. That's enough electricity to provide hot water for household use and part of the home heating as well (1178X1554-31).

Left: Standing tall at SEA's wind energy research facility in Bushland, Texas, this vertical-axis turbine supplies 40 percent of the energy needed for an experimental "wind-assisted" irrigation system. When winds are calm, an electric motor drives the irrigation pump. As soon as wind speeds exceed 13 mph, the turbine takes over (0678X796-29).

reported in the next article in this issue of *Agricultural Research*).

Agronomists, plant geneticists, and engineers at Peoria and 10 other locations will concentrate their studies on growing more energy per unit of land with plants that have sugar, starch, and cellulose biomass potential. Such crops will include sweet sorghum, sweet stalk corn, sweet potatoes, and both sugar and fodder beets. (An example of the research on sugarbeets is reported in the third article in this issue of *Agricultural Research*.)

This research will also include studies of the timing, frequency, and rate of use of various plant growth regulators that can increase plants' fuel source components. Genetic characteristics of plants chosen for the biomass research effort will be studied, too.

Another aspect of the biomass-to-alcohol work will be the actual collection of biomass with new or adapted harvesting equipment.

Researchers will seek the best possible harvest time for retention of biomass fuel potential, and the best ways to transport biomass from the field to the place where it will be converted into alcohol.


Top: Methane has been produced continuously in a cooperative SEA-state project at this University of Missouri swine farm since installation of an automatic anaerobic digester in 1976. Manure is flushed from farm buildings into a settling basin where it is concentrated into solids and pumped daily into a 20-foot diameter digester. Effluent from the digester and excess water from the basin flow into the lagoon, upper right (0280W188-6).

Above: Agricultural engineer James Fischer stands in the doorway of the equipment shed attached to the digester. Gases from the digester are temporarily stored in the adjacent gas bag for later use as energy sources (0280W188-26).


Above: University of Missouri-Columbia research specialist Jim Porter measures quantity of nitrogen in digested manure. Other biochemical analyses are conducted for total solids, volatile solids, volatile fatty acids, hydrogen ions, methane, and carbon dioxide (0280W186-10A).

Top right: Engineering technician Paul Little weighs effluent from the pilot-size digester to determine optimum loading rates for swine manure (0280W185-34A).

Right: University of Missouri-Columbia research specialist Mary Efchmann compares 2 cultures of isolated bacteria taken from the digester to determine the ideal nutritional mixture for converting manure into methane (0280W186-24A).

Opposite page:
A fermentation process for producing glucose from raw corn starch would save energy in making alcohol fuel. Grant St. Julian studies microorganisms that can digest corn starch to produce glucose (0180X061-10).

Different energy crops that need to be stored until the conversion process takes place may need special storage conditions to keep their fuel potential components "fresh." Storage research will be done in Belle Glade, Fla., and in Peoria.

**Leadership and Extension**

Each center will have a 3-person management team, composed of a center manager and two program leaders, one for research efforts and one for extension programs. The extension leader will work through the cooperative state extension services to transfer the new technology, gained by the research programs, to farm, ranch, and other energy consumers.

The extension education programs relating to Tifton will come first from ongoing research in solar and wind energy. These will include: heating rural homes, heating water for farm house and food processing uses, storing and conserving for commercial

greenhouses, using wind energy to pump irrigation water, and informing potential users about new solar energy collectors.

Since many biomass products are too bulky to move long distances, immediate extension activities will most likely involve on-farm burning to obtain biomass energy and the best ways that farmers and ranchers can use that new source of energy.

Extension activities related to the conversion of biomass to alcohol, and then its use for agricultural and other consumer needs, will be developed later at Peoria.

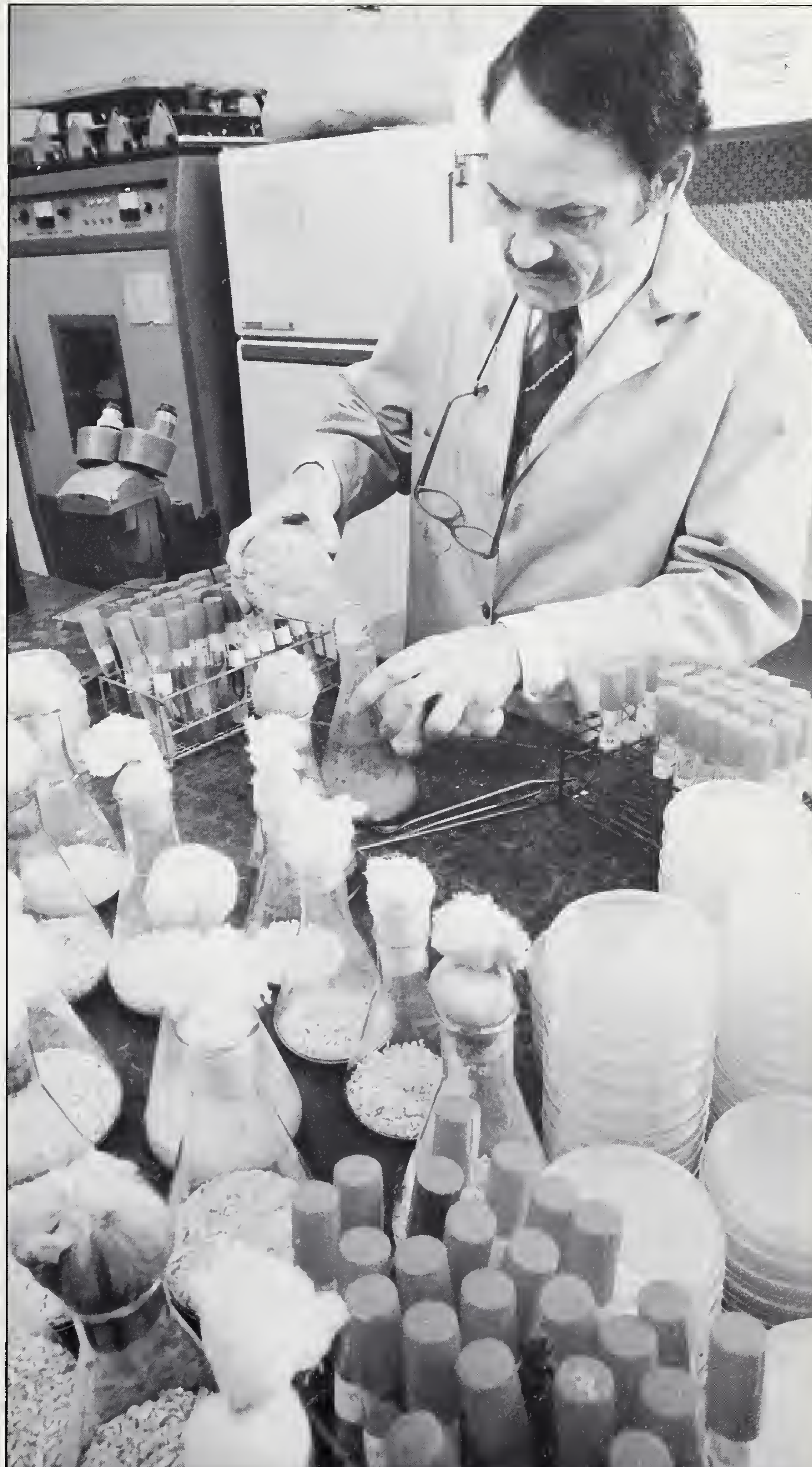
Managers of the new agricultural energy centers are James L. Butler, agricultural engineer, for Tifton; and chemical engineer Edward B. Bagley, for Peoria. The center staffs will include employees from SEA-Agricultural Research, SEA-Cooperative Research, and SEA-Extension.

SEA headquarters offices in Washington, D.C. will provide managerial coordination of programs. It will also help coordinate the programs of the centers with other USDA agencies, with the Department of Energy, and with other organizations at federal and state levels.

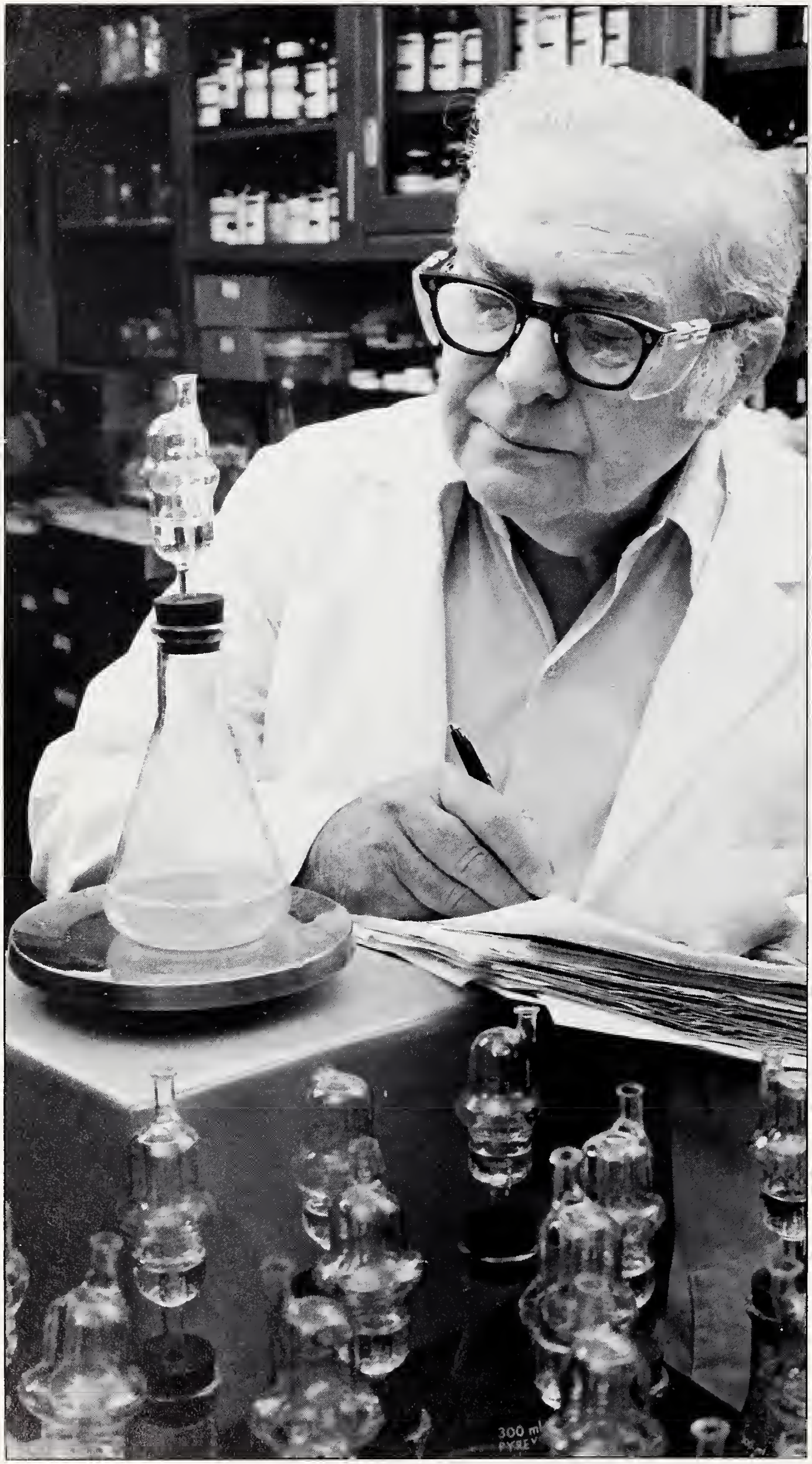
At the Peoria center many of the projects were already underway before the center was established. The Tifton center is not far behind in its organization and program efforts, and both center managers forsee full-speed programs and staffing by the middle of this summer.

Butler and Bagley agree that American agriculture can help solve the Nation's increasingly critical shortages and costs of petroleum fuels. The work to be done at the two new agricultural energy centers will help resolve those problems through the use of renewable and noncritical energy sources.

Dr. James L. Butler's address is Southern Agricultural Energy Center, Coastal Plain Experiment Station, Tifton, GA 31794. Dr. Edward B. Bagley's address is Northern Agricultural Energy Center, 1815 N. University, Peoria, IL 61604.—(By Stu Sutherland, SEA, Washington, D.C.)



# Plant Energy Packages Resist Pilfering



They're almost like kids in a candy store, but energy scientists will work harder for the sugar they need—glucose.

The need is intense. Natural fuel for living cells, glucose ferments easily to fuel alcohol.

The abundance is exciting. Plants package the sun's energy in glucose units and link the units in chains as starch for storage and as cellulose and hemicellulose for structures. As the major component of plant cell walls, cellulose is the most abundant organic material on earth.

But the packages are tantalizing. Plants pack the glucose chains in starch granules and cellulose fibers, like sugar in jawbreakers and candy canes, then wrap the granules in protein and the fibers in lignin.

The protein matrix that surrounds starch granules is glassy or gluey depending upon whether it's wet or dry, and the granules themselves resist dissolving in water until it's almost boiling. "Lignin is a natural plastic binder, a polymeric cementing material of which the exact formula is unknown," says R. W. Detroy, biochemist at the SEA Northern Regional Research Center, Peoria, Ill. It does not break down in acid solutions, but does dissolve in alkali.

In short, plants pack fast-energy sugars in slow-opening packages—as if the corner druggist put jawbreakers and candy sticks in childproof containers.

The multi-wrap packaging is understandable says Edward B. Bagley, manager of the Northern Agricultural Energy Center. He points out that unprotected sugar would disappear quickly in nature.

Whether in starch granules or in cellulose fibers, sugar is energy for all life—from bacteria and molds to redwoods and whales. Energy scientists seek fuel sources; they must save energy in opening the plant packages.

Davis weighs flasks to determine loss of carbon dioxide produced by *Zymomonas mobilis* growing on sugars. The loss indicates rate of alcohol production (0180X064-26A).

Just as plant cells package energy and recover it for cell fuel, other cells can open the package and ferment the glucose to alcohol. Yeast cells traditionally are used to convert sugar to alcohol. But energy scientists want more help from cells of microorganisms in opening the starch package and in fermenting the sugar to alcohol.

"One of our long range objectives is to find microbial strains with greater fermentative ability than strains traditionally used," says Rodney J. Bothast, Peoria Center microbiologist. "If fermentation alcohol is to be an economical fuel, the energy efficiency of converting starch to sugar and fermenting sugar to alcohol must be improved."

In the traditional production of alcohol from grain, starch is cooked then digested to sugars, which are fermented by yeast to alcohol. Cooking starch and distilling the fermented beer to purify the alcohol are energy-consuming operations.

Bothast says a mold used to make fermented food in Indonesia appears capable of penetrating protein matrix and starch granules and breaking glucose chains to help save energy in opening the starch package of glucose. *Amylomyces rouxii,* which ferments rice to laochao, a sweet food, may grow on cracked corn and produce glucose. This would shorten or eliminate the starch cooking operation.

A bacterium, *Zymomonas mobilis,* shows promise as an energy saver in converting glucose to alcohol. Edwin N. Davis, microbiologist, says at least one strain of the bacterium ferments sugar at higher temperatures than yeast can tolerate. Using the heat-tolerant bacterium would save some energy now used in cooling fermentors and some energy now used in reheating the fermented beer to distill it.

Just as they want more help from microorganisms in opening the starch package, Peoria center scientists are recruiting microorganisms to help remove the lignin wrapped around cellulose and hemicellulose in stems, stalks, straw, and other plant structures. They are adding microorganisms to the Agricultural Research Culture Collection and comparing wood-rotting fungi with grass-rotting fungi for the ability to degrade lignin.

Culture number NRRL 2366 in the Collection is a wood-rotting, edible fungus called the oyster mushroom, *Pleurotus ostreatus.* Growing on wheat straw, the fungus removed 22 percent of the lignin wrapper in 30 days and 38 percent in 62 days. Detroy, Lloyd A. Lindenfelser, Grant St. Julian, Jr. and William L. Orton did the research.

Detroy says, "The organism appeared to selectively degrade lignin during the first 6 days." After that, the mushroom, recruited to help unwrap the "candy", began filching some of the "canes". Cellulose losses reached 14 percent in 30 days and 28 percent in 62 days.

The mushroom freed more cellulose for digestion by enzymes to sugar than it used, however. While it was

Co-op student Diane Osborne boils powdered wheat straw in a reflux condenser to analyze cellulose and lignin. This condenser is used to recycle an acid solution to prevent loss through evaporation (0180X066-4).

## Plant Energy Packages Resist Pilfering

Student Scott Sommer examines oyster mushroom fungus growth on chopped wheat straw. The fungus, which grows naturally on hardwoods, digests lignin and frees cellulose for conversion to glucose (0180X060-18).

filching 14 percent of the cellulose, for example, it made 34 percent available for digestion to glucose. "After 50 days' fermentation," Detroy points out, "72 percent of the cellulose was available for digestion to glucose."

In sharp contrast, only a 72-hour treatment of straw with a chemical called ethylenediamine made 60 percent of the cellulose available, but the chemical corrodes metal and is toxic.

The oyster mushroom and similar "white-rotting" fungi are logical recruits to help unwrap the cellulose package. They live on energy from cellulose that is wrapped in lignin in hardwoods. Since the lignins in hardwood and straw differ, Donald T. Wicklow, microbial ecologist, hunted fungi that specialize in digesting grass family lignins. Top "specialists", he reasoned, would be among fungi that are last to colonize cattle dung because they would have to survive on grass cellulose remaining after digestion by cattle, insects, and early colonizing microorganisms. Such cellulose would be well wrapped in grass lignin.

"An unidentified mushroom found colonizing aged cattle dung in a Michigan pasture substantially outperformed eight other dung inhabiting fungi in degrading lignin in wheat straw," Wicklow says, "and in freeing cellulose for enzymatic hydrolysis to glucose."

The unidentified mushroom, now numbered NRRL 6464 in the Culture Collection, degraded 23 percent of the lignin in wheat straw in a 48-day experiment by Wicklow, Detroy and Stephen W. Adams. Maximum lignin breakdown by the other eight fungi was only 4 percent. Furthermore, all eight used more cellulose than they made available for enzymes to digest to glucose.

Since the eight "free-loading" fungi do colonize dung earlier than the unidentified mushroom, Wicklow was encouraged in the direction of his search. "The late-appearing mushroom is an ecological equivalent of a 'white-rotting' fungus in hardwood forest ecosystems," he says.

In a return visit to the Hickory Corners, Michigan, cow pasture, he "recruited" *Cyathus stercoreus,* numbered NRRL 6473 in the Culture Collection. It is one of a group called "fairy goblets" and "bird's nest fungi."

Growing 62 days on wheat straw, in a test by Wicklow, Detroy and Brent A. Jessee, the bird's nest fungus removed 45 percent of the lignin wrapper and exposed 61 percent of the cellulose for digestion to glucose by enzymes.

Although results from different studies are not directly comparable, Wicklow points out that the bird's nest fungus now ranks as top specialist in removing the lignin wrapper from cellulose in wheat straw.

Dr. Edward B. Bagley's address is Northern Agricultural Energy Center, 1815 N. University, Peoria, IL 61604.—(By Dean Mayberry, SEA, Peoria, Ill.)

# Hybrid Sugarbeets — Fuel from Fodder

Fueling humanity's future is an ever-increasing concern. The stumbling, stutter-stepped search for renewable energy sources seems at long last underway in proximate earnestness and SEA researchers are joining the hunt.

For example, in Logan, Utah, two plant geneticists, Devon L. Doney and J. Clair Theurer, are exploring the possibility of developing what they call a fuel beet—a hybrid sugarbeet especially bred for use in making alcohol fuel.

Alcohol fuel, of course, has incited much excitement and publicity in recent months, for in such forms as gasohol and ethanol it can replace some of the petroleum fuel used to power automobiles, planes, and other gas-guzzling machinery. Obtained from the fermentation and distillation of plants and plant residues, alcohol fuel is one renewable energy source for which technology is already available.

Of all the plants being considered for alcohol fuel production in the United States, none rivals the potential of sugarbeets. Currently, the easiest and cheapest means of producing alcohol fuel from biomass (the total dry weight of plant) is to extract it from fermentable sugars. Sugarbeets store 40 to 50 percent of their total biomass as fermentable sugars—15 to 20 percent better than figures for the other sugar crops, sweet sorghum and sugar cane.

Under today's conditions, sugarbeets represent a potential production of 400 to 550 gallons of alcohol fuel per acre at a net cost of $1.51 per gallon. These figures do not make alcohol fuel production from sugarbeets economical as of yet, but they at least indicate that such production is within early striking range.

More important is the energy balance. Unlike alcohol fuel production from cereal crops, where input energy continues to exceed output energy, fuel production from sugarbeets even now results in a positive (though slenderly so) energy balance.

Much improvement in all aspects of using sugarbeets for alcohol fuel production is needed before they can play any sort of significant role in the energy crisis. Imperative is the need for a new type of sugarbeet capable of yielding more fermentable sugars per acre than any present variety. Doney and Theurer hope to meet this need with development of their fuel beet.

"It should be easier to develop a beet for fuel than for sugar," says Doney. "In breeding for a fuel beet, we'll be aiming at increasing sugar quantity in the beet without having to worry about the quality factors that affect sugar crystallization."

Previous sugarbeet breeding programs focused on developing beets that, in addition to being high-yielding, produced the high concentrations of sucrose necessary for sugar crystallization. In fuel production, simple fermentable sugars are as good as sucrose.

Concentrating solely on total fermentable sugar enables Doney and Theurer to retrace their past efforts to see if any high-yielding beets were discarded for having poor sucrose concentrations. The researchers are also turning their attention to fodder beets.

Fodder beets are high-yielding, low-sucrose beets used for livestock feed in Europe. Estimated alcohol yields from fodder beets are 20 to 30 percent higher than yields from the best U.S. sugarbeets. The problem with fodder beets is that none of their varieties has any resistance to curly top, the number one virus disease of beets in this country. Without curly top resistance, fodder beets could not survive in the United States, especially in the large, beet-growing areas in the West.

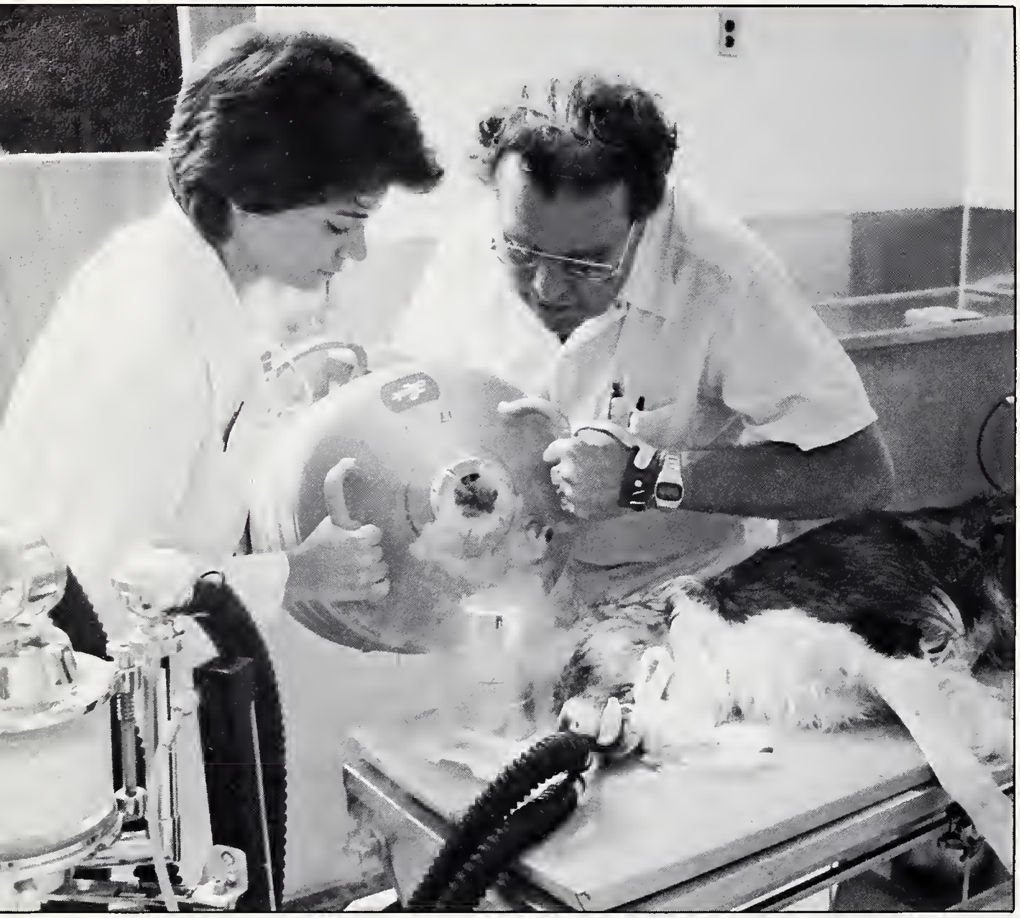
A cross between European fodder beets and U.S. sugarbeets is what Doney and Theurer envision their fuel beet to most likely be. Such a cross should give large yields and some curly top resistance, if curly top resistant female parent plants are used. Theurer has collected seed of some of the best fodder beet varieties from all over the world to work with.

Doney and Theurer's breeding efforts coupled with efforts by other researchers to further reduce costs—both monetary and energy—of converting beet sugar to alcohol fuel make the fuel beet feasible. The question is: Should crop land be used for fuel rather than food?

Timing seems to be right for the birth of the fuel beet. The world is being emptied of its fossil fuels; the era of renewable energy sources is here. Until the development and implementation of infinite energy sources such as solar or fusion, the use of bio energy will probably be necessary. Sugarbeets or fuel beets may help.

Dr. Devon L. Doney and Dr. J. Clair Theurer are located at Rooms 109 and 104, Crops Research Laboratory, Utah State University, Logan, UT 84322.—(By Lynn Yarris, SEA, Oakland, Calif.)

# Eyesight to the Blind?



Above: Veterinary student Patricia Saras and Farrell pour liquid nitrogen into a thermos to chill instruments used in treating anesthetized animals (0779X953-8).

Right: Farrell treats the affected eye by applying a cryoprobe, designed to freeze secretory cells inside the eye (0779X953-21).

Can he restore eyesight to the blind? No, but SEA veterinarian R. Keith Farrell, Pullman, Wash., can relieve the pain of glaucoma so that dogs, horses, and other animals can resume normal functions again.

Using cryosurgery techniques that have worked well in treating malignant melanoma (cancer) in animals (see *Agricultural Research,* Oct. 1978), Farrell has now made the treatment of glaucoma in animals a quick, simple, and inexpensive procedure.

Glaucoma occurs either when the fluid-producing glands in the eyeball secret too much liquid to be drained ¼ff, or, when the mechanism in the eyeball for draining off this liquid fails. In both cases, the result is too much fluid confined in the limited space of the eyeball. Pressure within the eyeball mounts to a painful intensity and vision is eventually lost.

Although it can be caused by a violent impact on the eyeball, glaucoma in animals is usually inherited. Cockerspaniels seem particularly susceptible to the disease. Until now, animals with glaucoma have not been treated because of prohibitive costs.

Farrell treats glaucoma by applying a copper rod that's been superchilled in −196°C. (−322°F.) liquid nitrogen to the afflicted eyeball for a few seconds at a time until the cornea of the eye is frozen. Freezing the eye clears up the glaucoma and the disease does not return.

Eyesight is not restored but, relieved of pain, animals apparently function well on their remaining four senses.

The copper rod's branding surface is built to fit the curvature of the eyeball (one size fits all for each animal species) and coated with silver. Silver is a better cold conductor than copper.

Using cryosurgery to treat glaucoma originated with human medicine, but the technique practiced on humans is far too expensive and complex to use on animals. Farrell's work has changed this situation.

Dr. R. Keith Farrell is located at the Animal Disease Research Unit, Washington State University, Pullman, WA 99164.—(By Lynn Yarris, SEA, Oakland, Calif.)

# Vegetative Snow Fences

Forage crops growing between narrow, parallel strips of tall wheatgrass (vegetative snow fences) produce 1,100 pounds more per acre—a 40 percent increase—than forages growing in open areas.

These wheatgrass barriers trap and hold snow on the forage areas. During spring snow melt, water enters the soil for later use by forages. Without grass barriers, snow is often blown off the crop area and isn't available for forage production.

In 4 years of tests near Akron, Colo., barriers annually increased soil water supplies by 2 inches in comparison to conventional cropping.

Wheatgrass, a perennial plant, doesn't have to be seeded every year like sudangrass, sorghum, and other annual plants sometimes used to trap snow. Barriers also protect crops and soils from drying winds and erosion.

"However, there are some disadvantages to tall wheatgrass barriers. They are oriented in an east-west direction to trap the maximum amount of snow. Thus, tillage must be in the same direction. On long, downhill slopes, which also are oriented east-west, some soil erosion could occur. Barriers also require regular weed control, and compete with forages growing near them for water," says SEA soil scientist Bentley W. Greb.

Tall wheatgrass is hardy for average conditions, but it can be damaged by severe winds and shattered by hail. Results also indicate that the crop area between barriers should be fallowed about every third or fourth year to assure sufficient water to keep grass barriers healthy.

Barriers are planted in narrow, double rows (12 to 18 inches apart) in May during the fallow season. Barriers can be 30 to 50 feet apart, varying according to width of seeding and harvesting equipment on each farm or ranch.

Barriers are not cut and grow 3 to 5 feet tall. Snow collects leeward onto the crop area between barriers. In the tests, 30 to 35 pounds of nitrogen per acre, applied prior to planting, helped provide the best forage yields.

"The system shows great promise for Great Plains areas north of Interstate Highway 70, from Colorado and Montana to Minnesota, where annual snowfall exceeds 25 inches," says Greb.

Trees and shrubs are not good barriers for adjacent crops because they take years to establish and use more soil moisture than grass barriers.

Bentley W. Greb is located at the U.S. Central Great Plains Research Station, P.O. Box K, Akron, CO 80720. —(By Dennis H. Senft, SEA, Oakland, Calif.)

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# Agrisearch Notes

**Planned Landscaping.** Plants, shrubs and trees bring more than beauty to our lives; they are also a source of shade and cooling.

As living things, they transpire and remain near air temperature. All things radiate heat in relation to their temperature. Objects near vegetation are spared great radiation because transpiration keeps the surface of vegetation cooler than surrounding objects. A person standing on a lawn feels cooler because the lawn is absorbing the sun's rays. The same person standing on pavement feels hotter because the hot surface reflects and radiates more energy upon the person.

A study of midday surface temperatures and energy exchanges in a residential landscape by Paul R. Nixon, Benjamin G. Goodier, and Wayne A. Swanson documents the contribution that plants make to cooling and energy conservation. According to their research, there is less radiation to a building in the presence of a plant landscape. A home shaded from direct sunlight has two-thirds less heat flowing into the home from the shaded wall as compared to the sunlit wall. A shaded roof contributed less than half the heat to the home as the sunlit roof.

When the sun was directly overhead, the sunshaded roof temperature reached over 140° F. Light colored roofing material can aid in keeping cooling costs down. A home should be shaded on the east and west side from the morning and afternoon sun in the summertime. The south side of a home can achieve shade from window overhangs. Shrubs and trees near a home must not impede air circulation in order to assure proper cooling.

Lawns or other vegetated surfaces are preferable to large unshaded, bare areas around homes such as paved driveways and walks. Besides radiation effects, such air surfaces heat up. A landscape design that shades the home in summer while at the same time providing good air circulation, contributes much to energy conservation and comfort.

Paul R. Nixon and Wayne A. Swanson, with SEA Soil and Water Conservation Research, and Benjamin G. Goodier, with Texas A&M University, are located at P.O. Box 267, Weslaco, TX 78596.—(By Eriks Likums, SEA, New Orleans, La.)

**Bees Better Strawberries.** Using the honey bee, *Apis Mellifera L.*, as a pollinator, the production and quality of two Louisiana grown strawberries—Tangi and Dabreak—have increased significantly.

Researchers used three treatments in the experiments—strawberry plots with bees, plots without bees, and open access plots. Plots with bees consisted of a hive confined in a cage. Plots without bees had a cage over the strawberry plots to exclude bees. Open, free access plots had no cage or hive in the plot. The scientists replicated the treatments four times.

They planted in random fashion the two varieties in two rows each per plot. Pollination started unbiasedly in all plots on February 20. As fruit ripened, the strawberries were picked and graded every 3 to 4 days. Six fruit pickings occurred from March 20 to April 6. Data from grading and seed counts were statistically analyzed.

The data revealed that both 'Dabreak' and 'Tangi' strawberries responded favorably to pollination by honey bees. Total production of fruit was greater in bee plots. More U.S. No. 1 and No. 2 grade strawberries were produced in plots with bees than those without bees or open access. The largest individual berries came from plots pollinated by bees. The amount of poor quality berries decreased, and seed production also improved in number and quality. The largest number of fertile seeds also were produced on bee pollinated plots.

According to Dr. J. J. Lackett of the Bee Breeding and Stock Center Laboratory, Box 82-B, Baton Rouge, LA 70808, and Dr. C. C. Burkhardt of the University of Wyoming, Plant Science Division, P.O. Box 3354, Laramie, WY 82071, strawberry growers can increase their gross income by using bees for pollination of their strawberry crop.—(By Eriks Likums, SEA, New Orleans, La.)